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Projections of the Demand for National Forest Stumpage by Region; 1980-2030

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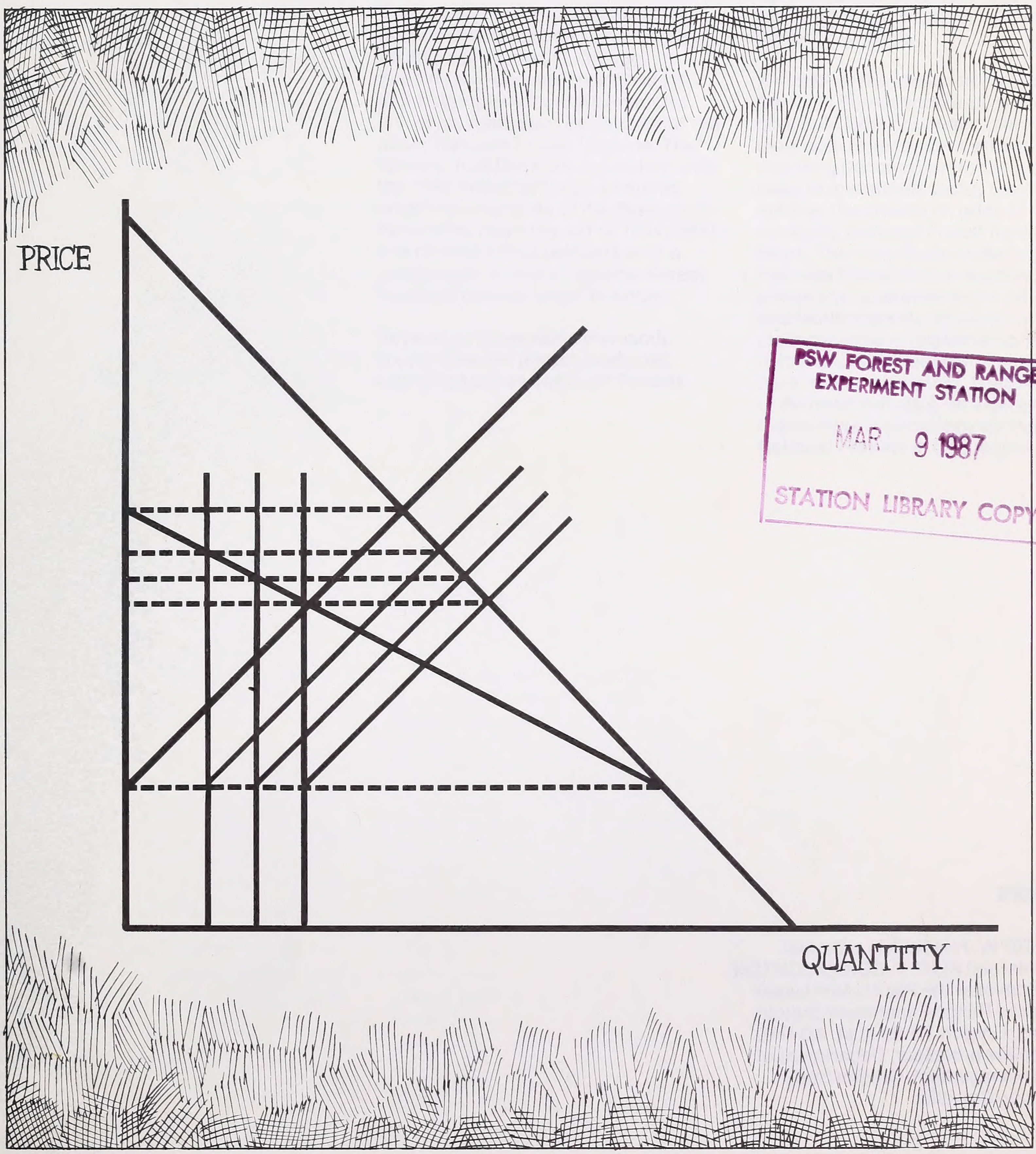

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Abstract

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The concept of regional demand is described and applied to the demand for National Forest stumpage. Specifically, demand functions for stumpage (price-quantity relationships) are developed by decade for the major National Forest Regions. The demand functions are consistent with the 1980 timber program prepared under requirements of the Renewable Resources Planning Act of 1974 (RPA) and provide forest planners with a mechanism to relate National Forest Regional harvest levels to prices.

Keywords: Projections (demand), supply/demand (forest products), stumpage prices, National Forests.

Summary

The National Forest Management Act of 1976 has stimulated interest in assessing demands for timber on National Forests as a price-quantity relationship. Assessments must be coinsistent with both economic theory and the projections of forest products markets made to support USDA Forest Service timber programs required by the Renewable Resources Planning Act of 1974 (RPA).

A model of Regional demand for National Forest stumpage is based on concepts from economic theory and uses data from the RPA efforts. The resulting demand relationships can be used to investigate policy questions such as the effects on price of changing National Forest harvest flows. The magnitude of the impact of National Forest timber supply on prices and quantities in the product and factor markets depends on the product-demand relationship, derived demand, and the supply of stumpage from other ownerships. The principles of demand that apply to a geographic region have implications for individual National Forests in that region.

Contents

Introduction

The National Forest Management Act (NFMA) (U.S. Laws, Statutes, etc. 1976) has lead to significant changes in National Forest planning. Some of the most important changes deal with economic concepts in planning. The regulations issued pursuant to the act specifically state that "projections of demand . . ., in conjunction with the supply cost information will be used to evaluate the level of goods and services that maximizes net public benefits; to the extent possible demand will be assessed as a price-quantity relationship (USDA Forest Service 1979)." This last statement has led to speculation about the nature of demand functions at both the National Forest and regional level—particularly how demand functions might be defined in ways that are consistent with both economic theory and the projections of forest products markets made to meet requirements of both the Renewable Resources Planning Act (RPA) (U.S. Laws, Statutes, etc. 1974) and the NFMA.

The purpose of this paper is to provide demand relationships for National Forest timber for each Forest Service Region (fig. 1A). These relationships can be used in planning at Forest Service regional and national levels. They are based on projections of softwood stumpage price and quantity that were made for each geographical region (fig. 1B) for the 1980 RPA effort (USDA Forest Service 1980a). Forest Service Administrative Regions are hereafter capitalized. The geographic regions used in RPA planning are not.

This paper deals only with regional demand for National Forest timber. It is written for National Forest planners and others interested in the planning process. Resource analysts and others interested in the effect on price of harvest levels on the National Forests may also find this information useful. Since regional harvest levels are likely to affect local prices, our results have implications for planning on individual National Forests. These implications, however, are not yet significantly developed and are only briefly discussed in this report.

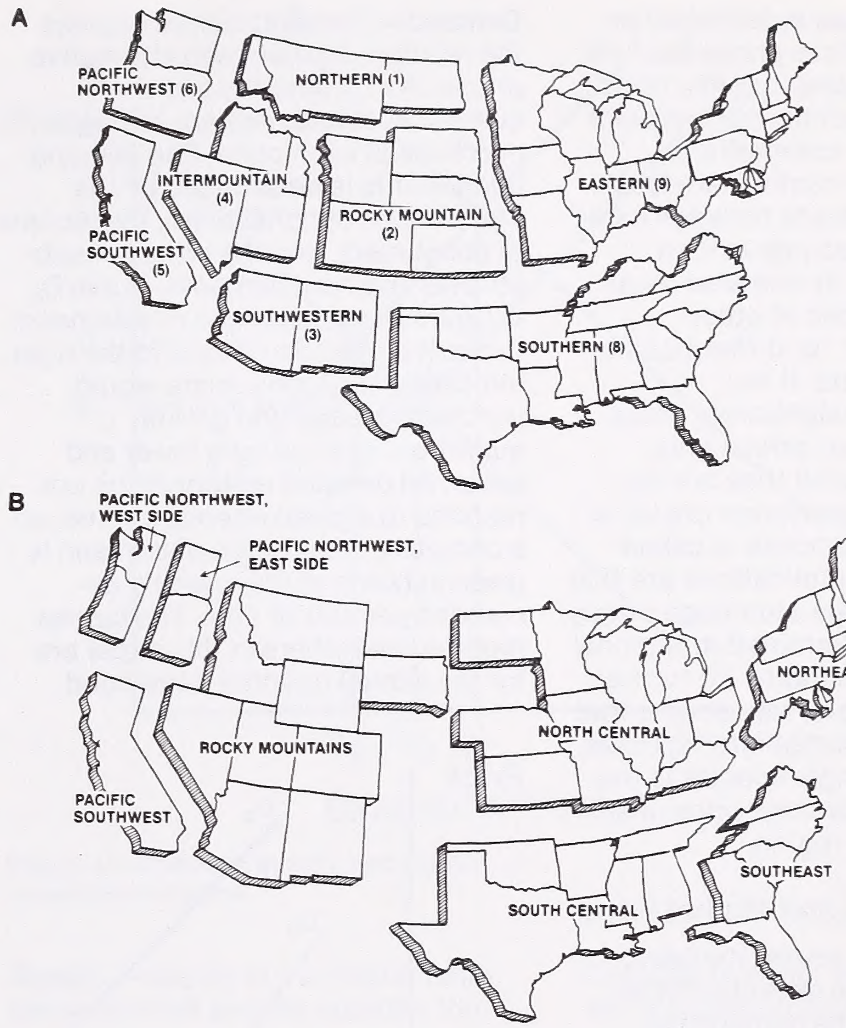

Figure 1A.—USDA Forest Service Administrative Regions excluding Alaska.

Figure 1B.—The 1980 Renewable Resources Planning Act (RPA) regions. Alaska is excluded in the analysis and Hawaii is added to the Pacific Southwest.

We view demand as the relationship between price and the maximum quantity of a good or service that buyers are willing to purchase. The demand for stumpage is derived from the demand for wood products. We further derive the demand of a region for stumpage on the National Forests from the demand for stumpage on all ownerships. Our approach is the same as that used in the Roadless Area — Intensive Management Tradeoff Study (Fight et al. 1978) to simulate the impacts of withdrawals of roadless areas on prices in a region. The demand curves and projections are fully consistent with the 1980 RPA assessment (USDA Forest Service 1980b) of the Nation's timber resource, and with the high bound recommended RPA program for the 1980's.

The paper is organized into three parts: (1) a discussion of the concept of regional demand and how it applies to stumpage on the National Forests, (2) projections of the demand curves, and (3) an interpretation of the results. The first section is prefaced by a review of the concepts of demand, supply, market price, and price elasticity. Examples are presented to illustrate the demand curves developed in the second part. The implications for planning on individual National Forests are discussed in the third part.

Regional Demand and Its Application to National Forest Stumpage

Stumpage prices are established on individual sales where prices capture differences in species, quality, transportation costs, technology, contract length, and bidder competition. Though stumpage markets are localized, unrestricted trade between local areas is possible, so prices for a particular species in one area must be in line with prices at other locations adjusted for differences in transportation costs. If not, purchasers from neighboring areas will buy in the lower priced area, driving prices up until they are the same (net of transportation costs) as other areas. This process is called arbitrage, and its implications are that we can treat average stumpage prices as if they were determined in regional rather than local markets. To further simplify our analysis, we assume that there is a single "composite" species. The price of our single species is the volume-weighted average price of all species within the region.

Demand, Supply, and Market Price

In this section, we review the basic concepts which are essential for an understanding of the demand for stumpage. Throughout, we make the assumption that regional stumpage markets correspond to the conventional notion of competitive markets.[1] In a competitive market, resources (stumpage) are efficiently allocated through the market forces of supply and demand.

[1]The traditional assumptions which underlie a competitive market are: 1) many producers and buyers, each too small to affect price, 2) homogeneous product, 3) producers and buyers have perfect information, and 4) producers are free to enter and leave the market.

Demand.—Demand curves express the relationship between alternative prices of a commodity and the quantities consumers are willing to purchase at each price. The demand relationship is determined by the preferences of consumers, the income of consumers, and the prices of substitutes and complements. Curve D_p in figure 2 is an example of a demand curve. It slopes downward to the right, indicating that consumers would purchase greater and greater quantities as price falls lower and lower. All demand relationships correspond to a given interval of time, so a complete description of demand is given in terms of the quantity demanded per unit of time. The curves reported elsewhere in this paper are for the annual quantity demanded.

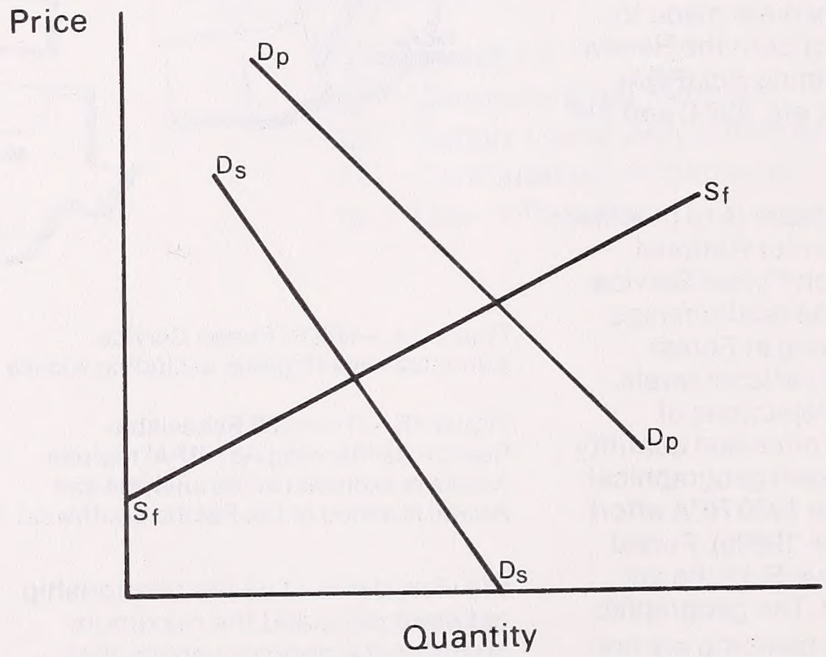

Figure 2.—The derived demand for stumpage.

The demand for stumpage is derived from the demand for wood products (Gregory 1972, Haynes 1977). Therefore, the shape and position of the regional demand curve for stumpage is dependent not only on the supply of stumpage from other sources and the supply of other manufacturing inputs for the wood products sector, but also on the shape of the demand curve for wood products. Figure 2 shows a graphical derivation of the demand for stumpage assuming a fixed coefficient production function.[2] The demand for wood products is shown as D_p and the supply curve for all factors of production **other** than stumpage is shown as S_f. The derived demand is the vertical difference between D_p and S_f and represents the maximum amount that could be paid for each quantity of stumpage while still compensating all other factors of production.

When we speak of a shift in demand, we are referring to a change in the position of the demand curve. Such a shift is shown as the change from D_1 to D_2 in figure 3. An example of such a shift would be the change in demand which we project through time (e.g. D_1 might correspond to 1980 and D_2 to 1990). A change in quantity demanded, however, corresponds to a movement along a demand curve.

[2]A fixed coefficient production function states that inputs are combined in fixed proportions to produce quantities of output.

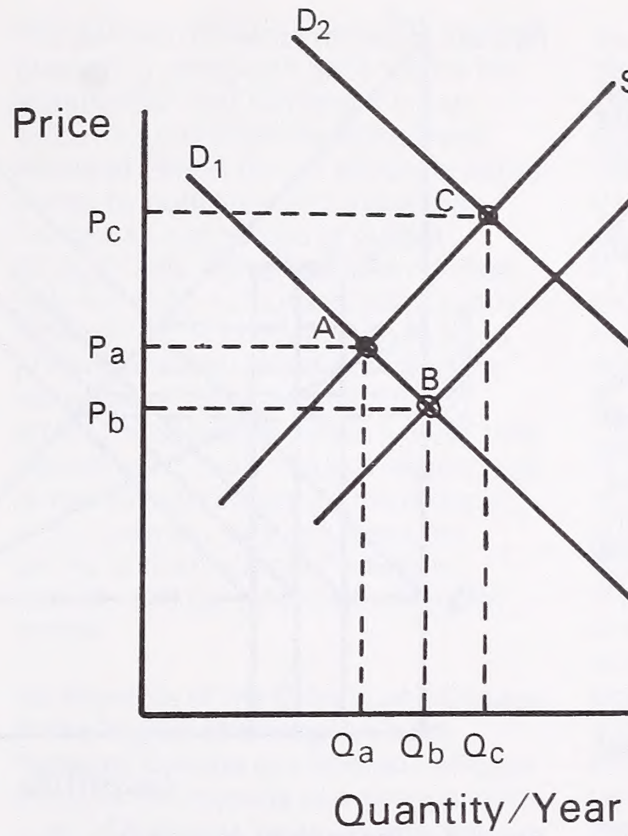

Figure 3.—Demand, supply, and market price determination.

Supply.—Supply is the relationship between price and the quantity that sellers would place on the market. Supply curves are, in general, upward sloping—the higher the price, the greater the quantity sellers would be willing to provide. Curve S_1 in figure 3 is an example of a supply curve. As with demand, supply curves apply to a stated interval of time. Shifts in a supply curve, as from S_1 to S_2 in figure 3, refer to changes in position.

The supply of stumpage from the National Forests is not considered responsive to price since the amount of timber offered is set by agency policies that generally do not consider current or expected future prices.

Market Prices.—Price is determined by the interaction of supply and demand forces. At a price of P_a (fig. 3), consumers are willing to purchase a quantity of Q_a; at the same time, suppliers are willing to provide Q_a at price P_a. Price P_a, therefore, is an equilibrium price in that the quantity demanded is equal to the quantity supplied.

Changes in either supply or demand will bring about a change in equilibrium price and quantity. For example, a shift in demand from D_1 to D_2 leads to a new equilibrium price of P_c for quantity Q_c. Had supply shifted instead as from S_1 to S_2, price would have fallen from P_a to P_b and quantity would have increased to Q_b.

Price Elasticity.—Elasticity is a quantitative measure of the responsiveness of quantity demanded (or the quantity supplied) to changes in price. The price elasticity of demand is the percentage change in quantity divided by the percentage change in price. Price elasticity of supply is similarly defined. Demand or supply is said to be elastic (inelastic) if the percentage change in quantity is greater (less) than the percentage change in price. Demand (supply) is unitary elastic if the percentage change in quantity is equal to the percentage change in price. Elasticities are either computed at a single point on a demand or supply curve (point elasticity) or between two points on the same demand or supply curve (arc elasticity).

Estimates of elasticity vary through time. The relationships in general become more elastic as technological improvements lower processing costs and industry shifts from less competitive regions to regions with greater competitive advantage. An increase in elasticity of stumpage supply from all sources other than the USDA Forest Service would also serve to increase the elasticity of the demand curve for National Forest stumpage, and, therefore, reduce the sensitivity of regional stumpage price to changes in National Forest supply. Finally, changes in the relative prices of substitutes, complements for wood products, and national income would change the elasticity of product demand, and hence the demand relationship for National Forest stumpage.

The Regional Demand for National Forest Stumpage

The regional demand for stumpage on the National Forests is the relationship between price in the regional stumpage market and the level of timber offerings on the National Forests. This relationship cannot be directly observed from market transactions since the National Forests contribute only a portion of the total quantity supplied in each region and it is total quantity that establishes regional prices. We can, however, deduce the relationship between price and National Forest timber offerings. Further, we can do this in a way that allows for simultaneous supply adjustments on other ownerships. The underlying economic model is a combination of the models of derived demand, excess demand (from the international trade literature), and the dominant firm (from oligopoly theory).[3]

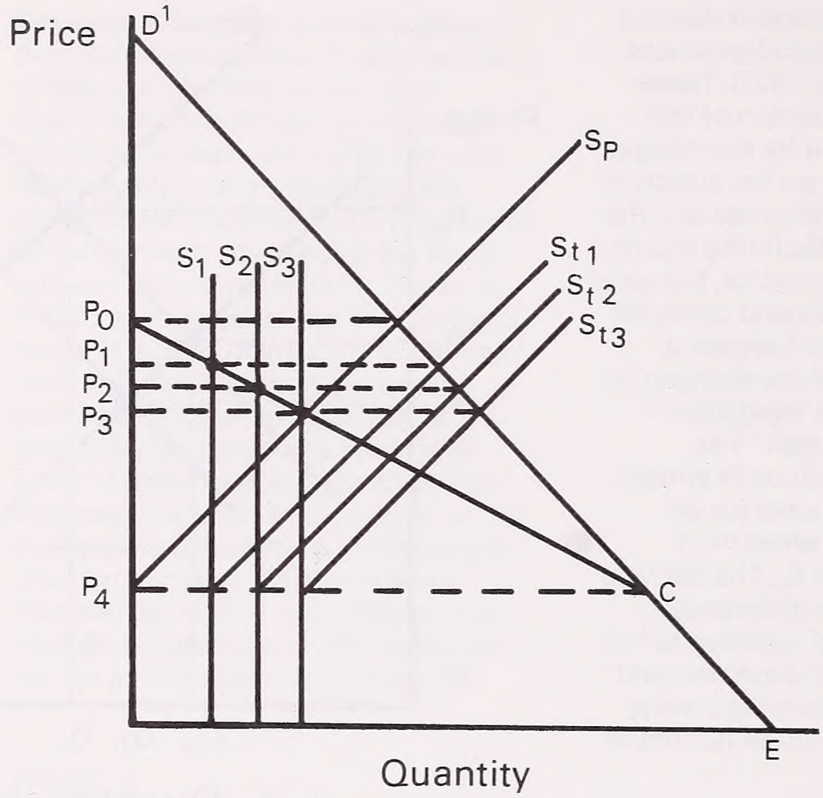

Figure 4.—The regional demand for National Forest stumpage.

Figure 4 displays the elements of demand and supply analysis that are necessary to determine the regional demand for National Forest timber. The supply curves for stumpage for all ownerships other than the National Forests have been consolidated and are represented by the curve S_p. The demand curve for timber (from all ownerships) is D^1E. Three different levels of National Forest harvests are shown: S_1, S_2, and S_3. Total supply is the sum of supply from the National Forests and all other ownerships. Graphically, total supply is the horizontal sum of the two supply components and is labeled S_{t1}, S_{t2}, and S_{t3} for each of the different National Forest harvest levels.

[3]Further detail on this model and several common alternatives are provided in Connaughton,Kent and Richard W. Haynes. The regional derived demand for stumpage on the National Forests. (In press) USDA For. Serv., Pacific Northwest For. and Range Exp. Station, Portland, Oreg.

Price is determined by the intersection of demand and total supply. If the National Forest harvest level is S_1, price is P_1, if the National Forest harvest level is S_2, price is P_2, and if the National Forest harvest level is S_3, price is P_3. The effect of changing National Forest harvest levels is to shift the total supply curve. The locus of points from the intersection of price and alternative National Forest harvest levels is graphically depicted as P_0CE and is the regional demand for National Forest timber.[4]

The demand for National Forest timber is more elastic than the regional derived demand for timber from all ownerships. This elasticity depends on the elasticity, or slope, of the supply relationships for other ownerships. An increase, for example, in the National Forest harvest level shifts total supply to the right, leading to a lower price and a simultaneous reduction in quantity. Reductions in the quantity supplied from other ownerships offset the increase in National Forest harvest if the supply curve for other ownerships is not totally inelastic. With the reductions in the quantity supplied from other ownerships, the change in the total quantity supplied in the region is less than the change in the quantity offered for sale on the National Forests, and the demand for stumpage on the National Forests is more elastic than the derived demand for stumpage on all ownerships.

[4]The kink that occurs are point C is of limited significance since in actual practice it is unlikely to be observed. It represents the point where National Forest harvest levels are high enough to lower prices to such an extent that private supply is zero.

The pattern of events traced out in the preceding paragraph depends on the assumption that National Forest timber supply is perfectly inelastic. National Forest timber supply is established by policies which treat the harvest as a schedule of output through time rather than the relationship between output and price in any time period. Therefore, though price projections may affect the temporal schedule of harvests, they do not affect the schedule within a given time period (say 1 year). Budget restrictions or market conditions on the demand side, however, may influence the ability of the National Forests to actually sell the intended volume of timber.

An Example of the Effects of a Change in the Supply of Stumpage from National Forests in a Region.—Figure 5 traces the impacts of a change in the level of National Forest supply on stumpage price, harvest from other ownerships, total harvest from all ownerships, lumber price and lumber production. Lumber demand (DD), derived demand for stumpage (D^1E), demand for National Forest stumpage (P_oCE) and stumpage supply from other ownerships (S_p) are the same as shown in figure 4. National Forest supply is established during the forest planning process and can be represented as a totally inelastic (nonprice responsive) supply curve. Suppose that the supply from the National Forests increases from O to ON. The total supply of stumpage increases from S_p to S^1. The harvest from other ownerships contracts from OA to OA^1 because the increased Federal harvest drives down stumpage price from P_o to P_2. Total harvest increases from OA to OF, though the magnitude of the change in the total is less than the increase in the National Forest supply because of the offsetting decrease in the harvest from other ownerships. Lumber production increases because of the decrease in stumpage price, and lumber prices fall from P_{L1} to P_{L2}. The magnitude of the impact of changes in the supply of stumpage from the National Forest on prices and quantities in the product and factor markets depends on the product demand relationship, derived demand, and the supply of stumpage from other ownerships.

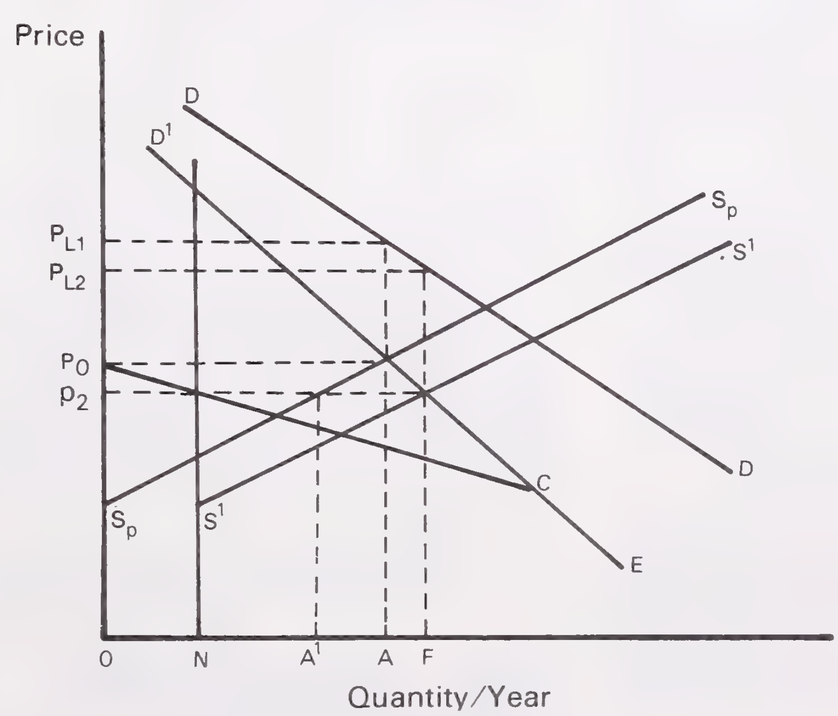

Figure 5.—The effect of a change in National Forest harvest on the price of stumpage, harvest from other ownerships, total harvest, lumber price, and lumber production.

Demand Projections

Table 1—Demand equations for National Forest stumpage, by region and selected years 1980-2030[1]

Region	Selected years[2]											
	1980		1990		2000		2010		2020		2030	
	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope
Pacific Northwest												
West side	122.43	–.091	164.73	–.104	160.10	–.115	191.73	–.126	226.44	–.140	226.59	–.157
East side	102.69	–.275	137.09	–.282	149.95	–.287	174.81	–.293	202.86	–.300	227.97	–.307
Pacific Southwest	93.06	–.161	131.15	–.178	149.35	–.190	177.45	–.201	197.21	–.212	223.81	–.224
Rockies	185.63	–.307	234.18	–.318	263.73	–.331	308.18	–.345	344.41	–.361	403.17	–.380
Northern	100.14	–.307	142.10	–.318	163.73	–.331	204.40	–.345	237.88	–.361	294.58	–.380
Rocky Mountain	48.60	–.307	80.32	–.318	90.22	–.331	113.36	–.345	132.47	–.361	172.90	–.380
Southwestern	51.37	–.307	77.77	–.318	85.59	–.331	108.53	–.345	127.41	–.361	167.96	–.380
Intermountain	52.29	–.307	80.32	–.318	88.57	–.331	111.29	–.345	130.30	–.361	169.86	–.380
Southeast	58.97	–.077	87.71	–.077	107.97	–.078	135.57	–.078	164.86	–.078	198.06	–.079
Southcentral	64.27	–.054	93.99	–.054	114.74	–.054	145.16	–.055	176.42	–.055	211.56	–.056

[1]Equations are of the form: price = intercept + (slope x quantity); where quantity is annual National Forest supply in millions of cubic feet and where annual price is in 1967 dollars per thousand board feet (Scribner).

[2]Equations for nonselected years can be computed by interpolating both the intercept and slope terms.

The regional demand for stumpage on the National Forests is the relationship between the average regional price of stumpage and the volume of timber offered for sale on the National Forests within the Region. Table 1 displays the demand relationship, by Region, for each benchmark year for the decades 1980-2030. The results in table 1 are of the form

$$P = a_o + a_1 S \qquad (1)$$

where P is regional price, a_o is the price which would prevail if National Forest supply were zero (intercept), a_1 is the rate of change of price with respect to a change in National Forest supply (slope), and S is annual volume of timber offerings on the National Forests (millions of cubic feet).[5] All prices are in 1967 dollars per thousand board feet, short log Scribner scale except for the Pacific Northwest westside which is in long log, Scribner. Therefore, prices are net of inflation. Regional price reflects the volume-weighted average price for all species. The development of regional prices for individual species is discussed in Haynes et al. (1980). Figure 6 is a graphical example of how the demand curves change over time (curves are for the Southwestern Region, Region 3).

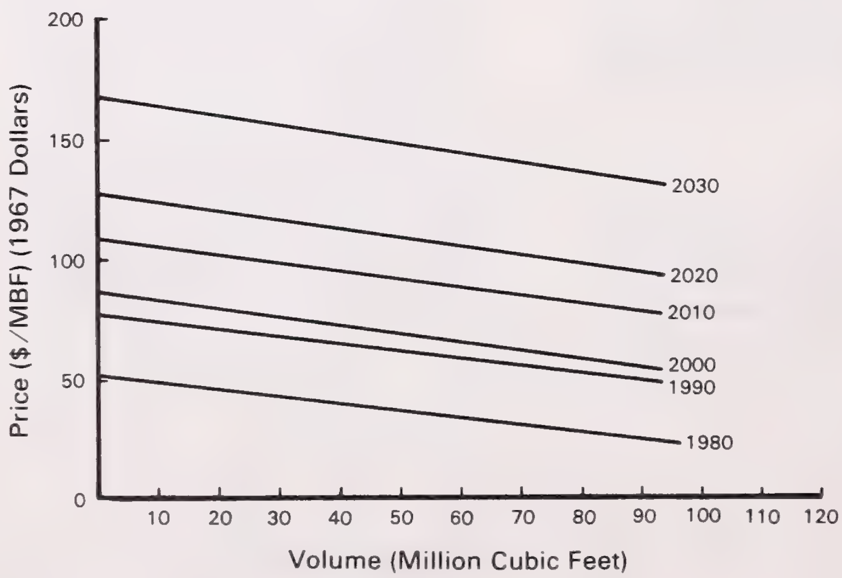

Figure 6.—Demand curves, by selected years, for stumpage from National Forests of the Southwestern Region.

[5]The equations in table 1 do not represent the kinked relationship shown in figure 3. See footnote 4.

The results in table 1 were calculated from the Timber Assessment Market Model (TAMM) (Adams and Haynes 1980). Our procedure was to calculate the supply curve for all ownerships other than the National Forests and then compute the derived demand for National Forest stumpage, using a mathematical procedure equivalent to the graphical method explained in the previous section. The output from TAMM provided us with the annual supply and derived demand functions for stumpage for each decade for all ownerships. To determine the supply from other ownerships, we subtracted the highbound RPA projections of National Forest harvest from total supply. An additional special procedure was formulated to disaggregate the RPA Rocky Mountain regional demand curve into demand curves for the Northern, Rocky Mountain, Southwestern, and Intermountain Regions (USDA Forest Service Regions 1, 2, 3, and 4). Details of the methods and assumptions used to obtain the results in table 1 are found in appendix 1.

Example

One use of regional demand functions is to quantify the impact of National Forest timber offerings on regional prices. For example, suppose that several Pacific Northwest, westside National Forests adopted a policy of departing in 1990 from nondeclining even flow by 37 million cubic feet. The projected RPA harvest level is 663 million cubic feet (see appendix 1). The price before departure is calculated by substituting 663 million cubic feet into the appropriate equation 1:

$$P = 164.73 - .104\,(663) \qquad (2)$$

The projected 1990 price, before departure, is $95.78 per thousand board feet in 1967 dollars. When the harvest is increased to 700 million cubic feet, price declines by $3.85 to $91.93 per thousand board feet. The latter price would be the expected average annual price which would prevail in the region during the 1990's so long as the annual National Forest supply remained at 700 million cubic feet.

These price impacts do not necessarily have to be expressed in 1967 dollars, nor do they have to be expressed in real terms. For example, the 1990 price in terms of 1979 real dollars is $95.78 times (2.355) = $225.56 where 2.355 is the 1979 wholesale price index (1967 = 100). Another way to express the 1990 price is in terms of the 1979 nominal prices. Suppose, for example, that the average Pacific Northwest region (westside) price in 1979 was $300.31. If we wished to express the price impacts of our departure example in 1979 nominal dollars (prices observed in the market in 1979), we would solve the ratio

$$P_{1990,\,1979} = P_{1979} \times \frac{P_{1990,\,1967}}{P_{1979,\,1967}} \qquad (3)$$

where

$P_{1990,\,1979}$ is the price in 1990 in 1979 dollars

$P_{1990,\,1967}$ is the predicted price in 1990 in 1967 dollars (calculated using the curves in table 1, $91.93 in our example)

P_{1979} is the average price observed in 1979

$P_{1979,\,1967}$ is the predicted price in 1979 in 1967 dollars (calculated using the 1980 curves in table table 1 as a proxy for 1979)

In our example, $P_{1990,\,1979}$ would be $392.78.

To express our results in some other year's dollars, we would change the 1979 subscripts in equation (3) to the desired year and proceed to solve the new equation. Another way of expressing the price impacts would be in 1990 nominal dollars which requires some assumptions regarding the rate of inflation.

Implications for Prices

The price implications of the curves described in table 1 can be demonstrated by comparing the price elasticities of the derived demand for stumpage on all ownerships with the elasticities of the curves for the National Forests. These elasticities for 1980, 2000, and 2030 are shown in table 2.[6] The derived demand curves for all owners are, in the near term, quite close to one another, but regional differences are more pronounced among the elasticities for National Forest stumpage. As a rule of thumb, the elasticity varies inversely with the importance of Forest Service harvest. In the South, where Forest Service harvest is a small component of total harvest, demand is very elastic, especially in the long run.

The estimates of elasticity increase through time. In an earlier section, we discussed the reasons for this from a conceptual viewpoint. Another way to view this change is that, as the equilibrium intersections shift out through time, they also shift upward. Given that our linear demand equations shift outward (up) through time more than our supply curves shift out, the result will be that the equilibrium price and quantity pair will occur in portions of the demand curve which have increasingly higher elasticities.

[6]All elasticities are computed using the equilibrium quantities and prices shown in tables 4 and 5, appendix 1.

Table 2—Elasticities of derived demand for stumpage for all ownerships and for National Forests by region, for 1980, 2000, and 2030[1]

Region	1980 All ownerships	1980 National Forests	2000 All ownerships	2000 National Forests	2030 All ownerships	2030 National Forests
Pacific Northwest						
West side	.100	1.343	.122	1.036	.219	1.467
East side	.099	.316	.198	.692	.285	1.055
Pacific Southwest	.099	.761	.152	.920	.214	1.219
Rockies	.044	.136	.091	.262	.183	.499
Northern	[2]—	.285	—	.503	—	.836
Rocky Mountain	—	.842	—	1.546	—	3.458
Southwestern	—	.762	—	1.779	—	3.963
Intermountain	—	.739	—	1.622	—	3.753
Southeast	.041	13.310	.052	20.705	.070	18.843
Southcentral	.110	6.905	.146	8.836	.195	7.814

[1]Computed using the RPA recommended highbound program levels for National Forest Timber supply (table 4, appendix 1), equilibrium prices (table 5, appendix) and the demand curves from table 1 (text) and table 3 (appendix 1).

[2]Values not computed.

We did not compute elasticities for all owners (total derived demand) for the individual Forest Service Regions in the Rockies. Comparisons, however, can be made between the elasticity of derived demand for Forest Service stumpage for each Forest Service Region and the total elasticity for the entire region. In general, the Forest Service has the greatest impact on stumpage prices in the Rockies and in particular the Northern Region.

Market Imperfections and Stumpage Prices

A complete specification of the demand for stumpage would recognize the multitude of market interactions which affect the value of products and factors in the wood products sector. Since pure competition describes or approximates the process through which value is assigned to any unit of timber, it is consistent to view the aggregate of many differentiated markets as a perfectly competitive market. Mead (1966) characterizes the Douglas-fir lumber industry as competitive in the product market and as both competitive and oligopsonistic (small number of buyers) in the stumpage market. Oligopsony might lead to lower prices than would be the case if there were perfect competition in the factor market. Therefore, results based on a perfectly competitive model are likely to overestimate actual observed prices which result from a combination of perfect competition and oligopsony.

Implications for Individual National Forests

The principles of derived demand that apply to a region also apply to local areas, subregions, or individual National Forests. The analysis of the individual Forest is complicated by three important factors: 1) species differentiation, 2) the impact of alternate sources of stumpage on local demand, and 3) local market imperfection. The effect of market imperfections has already been discussed. Though we abstracted from the case of multiple species at the regional level, such a simplification is likely to be misleading on individual National Forests. To complete the link between regional price projections for all species combined and projections for individual species on a National Forest, the reader is referred to Haynes et al. (1980). Their approach is to assume that a simultaneous change in harvest levels throughout a region will be translated into a regional price change which serves as a demand (or price) shifter on individual Forests. The shift in the demand (price) for stumpage which takes place on an individual Forest is conceptually equivalent to a change which would result from a change in the price of a substitute for local stumpage. A rigorous statement of the link between regional and National Forest demand, however, awaits further work.

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Appendix 1

Table 3—Coefficients of the derived demand equations for stumpage on all ownerships combined, by region and selected years, 1980-2030[1]

Region	Decade beginning . . . 1980 Intercept	1980 Slope	1990 Intercept	1990 Slope	2000 Intercept	2000 Slope	2010 Intercept	2010 Slope	2020 Intercept	2020 Slope	2030 Intercept	2030 Slope
Pacific Northwest												
West side	769.76	−.28	801.96	−.28	743.57	−.30	795.59	−.31	838.40	−.32	878.00	−.33
East side	272.87	−.44	343.97	−.46	370.73	−.47	420.30	−.49	466.55	−.51	527.98	−.52
Pacific Southwest	447.89	−.47	514.22	−.49	540.52	−.50	602.63	−.52	643.85	−.54	697.26	−.56
Rockies	527.56	−.49	605.52	−.51	654.70	−.53	726.68	−.55	781.85	−.57	866.76	−.59
Southeast	1,386.49	−.62	1,783.29	−.64	2,064.80	−.66	2,361.26	−.69	2,622.55	−.71	2,866.08	−.74
Southcentral	565.42	−.20	710.36	−.21	810.07	−.21	935.47	−.22	1,049.13	−.23	1,154.38	−.24

[1]Equations are of the form: price = intercept + (slope x quantity); quantity is equilibrium total harvest on all ownerships combined in millions of cubic feet (see table 4), and price is in 1967 dollars per thousand board feet (Scribner).

Computational Methods

The data for computation of the derived demand for stumpage on National Forests were taken from the Timber Assessment Market Model (TAMM) (Adams and Haynes 1980). TAMM is a simulation model that combines a spatial econometric market model with a biological growth model of the resource base. This approach allows for detailed projections of market activity on a regional basis and considers differences in regional resources, production costs, consumer preferences, and transportation costs. It recognizes that over time, competitive economic forces dictate shifts in the location of facilities processing.

In the stumpage sector of TAMM, aggregate derived demand and supply relations interact to determine the level of timber harvests (by owner group) and the price of stumpage. Derived demand is the sum of requirements for each major product category: lumber, plywood, pulp products, miscellaneous products, fuelwood, and log exports. Functionally, derived demand relationships are negatively sloped price quantity relationships where the value for the slope depends on the product supply and demand relationships. The derived demand equations for all ownerships combined are displayed, by region and decade, in table 3.

Stumpage supply relationships are the total of projected harvests from National Forest and other public land and the stumpage supply relationships for forest industry, and farmer and miscellaneous private owners. Our results are based on simulated National Forest harvest levels near those recommended in the 1980 highbound RPA timber program. The projected National Forest harvest levels and the sum of the equilibrium harvest for all other ownerships for each region (table 4) were used to compute the elasticities in table 2. The projected equilibrium prices are determined by the intersection of supply and demand in the stumpage sector of each region (table 5). Historical prices are included to aid in the interpretation of trends. The prices in table 5 were used to calculate the elasticities in table 2 of the text.

Table 4—Projections of equilibrium softwood harvest levels,[1] by region and selected years, 1980-2030

(In million cubic feet)

Region	1980	1990	2000	2010	2020	2030
Northeast						
All public	29	41	52	60	65	68
All private	466	555	610	665	727	779
North Central						
All public	75	87	116	125	123	119
All private	193	228	259	302	356	402
Southeast						
National Forest	53	55	64	89	114	127
Other public	76	72	72	72	72	73
All private	2,023	2,526	2,819	3,082	3,268	3,411
Southcentral						
National Forest	152	185	214	298	382	426
Other public	43	49	51	53	54	54
All private	2,348	2,786	3,025	3,269	3,430	3,545
Rocky Mountains						
National Forest	533	582	631	672	692	707
Other public	84	79	79	79	79	79
All private	412	433	428	439	441	458
Pacific Southwest						
National Forest	327	376	409	446	448	450
Other public	24	16	16	18	18	18
All private	513	530	504	521	533	554
Pacific Northwest-west side						
National Forest	573	663	678	678	685	685
Other public	480	395	400	425	450	475
All private	1,483	1,414	1,158	1,144	1,089	1,016
Pacific Northwest-east side						
National Forest	283	362	372	372	374	374
Other public	102	131	132	135	138	141
All private	179	211	216	238	255	281

[1]The harvest levels necessary to maintain an equilibrium between projected timber demands and supplies.

Table 5—Historical trend,[1] softwood stumpage price levels,[2] and projections of equilibrium prices,[3] for selected years, 1980-2030

($/MBF, Scribner log scale)

Region	1952	1962	1970	1976	1978	1980	1990	2000	2010	2020	2030
Pacific Northwest											
West side[4]	16.64	28.84	44.84	62.40	69.68	69.79	95.19	81.04	105.23	129.64	157.76
East side	15.77	18.22	20.43	22.27	22.92	24.63	53.76	61.35	79.63	94.41	116.98
Pacific Southwest	12.45	19.04	26.73	34.49	37.53	40.22	64.21	71.53	87.66	102.37	122.95
Rockies	6.45	9.29	12.40	15.42	16.58	22.22	48.80	54.79	76.47	94.56	134.12
Southcentral	21.43	30.88	41.37	51.49	55.40	56.13	83.47	103.05	128.79	155.26	188.19
Southeast	21.43	30.88	41.37	51.49	55.40	54.83	83.99	102.96	128.63	155.96	188.13

[1]Prices on a least squares regression line fitted to time series price data for the years 1950-78.
[2]Prices are measured in constant (1967) dollars and are net of inflation or deflation. They measure price changes relative to the producer price index.
[3]Prices which would result from stumpage prices rising enough to maintain an equilibrium between projected timber demands and supplies. These stumpage prices correspond to statistical high bid.
[4]Prices measured with long log Scribner scale.

Supply Curve Adjustments

Computation of the demand for National Forest stumpage begins with an adjustment which subtracts National Forest harvest from the supply curve for all owners combined (from TAMM). Total regional supply functions are conceptually the sum of supply from private and public ownerships. Private stumpage supply relations differ from those for public owners in that private owners are viewed as setting the quantity supplied (Q_s) based on stumpage prices (P) and levels of inventory (I). This latter variable represents the available resource stock. For forest industry or farmer and other private owners, the estimated stumpage supply function for each year is of the form

$$Q_{sk} = B_{k1} + B_{k2}P + B_{k3}I_k \qquad (4)$$

where

k is an ownership subscript and
$B_{1\text{-}3}$ are the estimated coefficients.

Total regional supply functions were computed in a given year by combining with the intercept term the nonprice terms for each private owner and the harvest levels for public owners. This assumes that public harvest shifts the location of the total supply function but does not affect the slope (price responsiveness) of the function. The total supply equation (Q_s) for a region is then expressed as

$$Q_s = [(B_{11} + B_{13}I_1) + (B_{21} + B_{23}I) + H_1 + H_2] + (B_{12} + B_{22})\,P \qquad (5)$$

where

H_1 is the National Forest harvest level and
H_2 is the other public harvest level.

The price variable in both equations is the volume-weighted, all-species average for a particular region. The inventory term, in addition to being owner specific, is also region specific.

Computation of Demand

Price equilibrium is determined by the intersection of supply and demand in the stumpage market. To obtain the demand for National Forest stumpage, therefore, we set derived demand (from table 3) equal to the right-hand side of equation (5) above, while allowing H_1 to remain as a variable. We then solve for price as a function of National Forest supply. For example, the following total stumpage supply, derived demand, and National Forest harvest levels (Q_{nf}) apply to the Pacific Northwest westside region, 1980:

$$Q_s = 2019.003 + 7.399\,P \qquad (6)$$
$$Q_d = 2796.700 - 3.6332\,P \qquad (6a)$$
$$Q_{nf} = 573. \qquad (6b)$$

We subtract (6b) from (6) to obtain the supply from all ownerships other than the National Forests. Total supply, therefore, is

$$Q_s = (1446.003 + Q_{nf}) + 7.399\,P \qquad (7)$$

To obtain the demand for National Forest stumpage we set equation (7) equal to equation (6a) and solve for P as a function of Q_{nf}:

$$P = 122.432 - .091\,Q_{nf} \qquad (8)$$

Equation (8), then, is entered in table 1 (text).

Use of Results

As with any econometric or simulation technique, the equations we derive here are expected to provide the best prediction of price impacts for a range of quantities close to those which have been historically observed. For example, though we have reported the vertical intercept and have interpreted it as the price which would prevail in the absence of any National Forest harvest, we do not have a data set which includes such a point. It and other points outside the range of historical data should, therefore, be used with caution.

Haynes, Richard W., Kent P. Connaughton, and Darius M. Adams.
1981. Projections of the demand for National Forest stumpage, by Region, 1980-2030. USDA For. Serv. Res. Pap. PNW-282, 13 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

The concept of regional demand is described and applied to the demand for National Forest stumpage. Specifically, demand functions for stumpage (price-quantity relationships) are developed by decade for the major National Forest Regions. The demand functions are consistent with the 1980 timber program prepared under requirements of the Renewable Resources Planning Act of 1974 (RPA) and provide forest planners with a mechanism to relate National Forest Regional harvest levels to prices.

Keywords: Projections (demand), supply/demand (forest products), stumpage prices, National Forests.

The **Forest Service** of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.

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